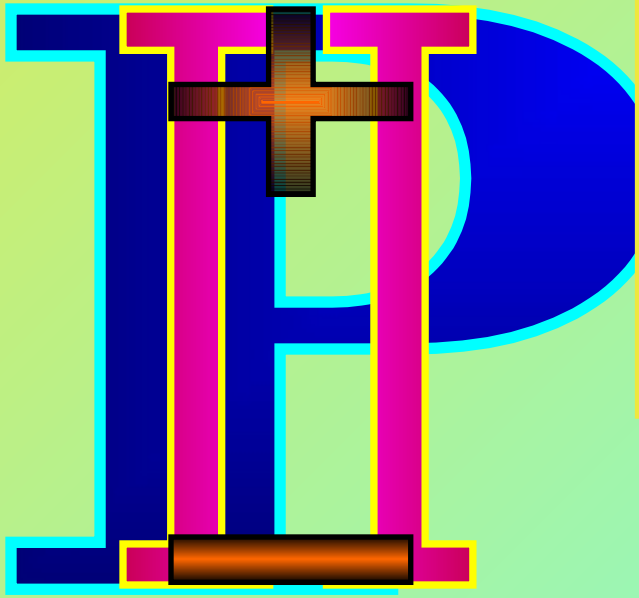
DC:

PARALLEL CIRCUITS

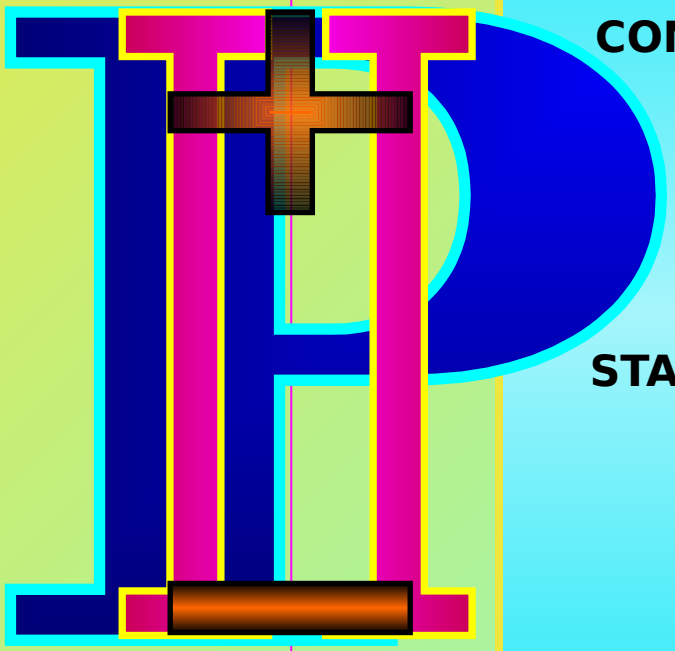


Unclassified:

2 Hour Conference W/2Hr. PE1

Safety & Environmental Impact: “LOW”

Terminal learning Objective.



ACTION: Calculate the DC voltage, DC current, and resistance in a parallel circuit.

CONDITIONS:

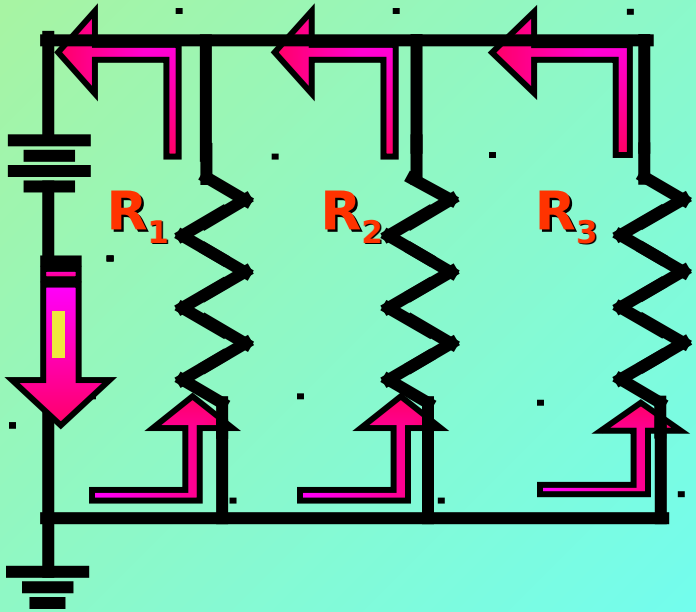
Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130A electronics trainer, digital Multimeter w/test leads, PC-130-8A and PC-130-8B circuit cards, schematic diagrams, calculator and official OMEMS reference materials.

STANDARDS:

Be able to identify parallel circuits characteristics, calculate voltage, current, and resistance values in a parallel circuit, properly measure voltage, current, and resistance in a parallel circuit, and compare to calculated values to the established standard of 7 correct answers out of 10 & 8 out of 10 for EOD.

Introduction

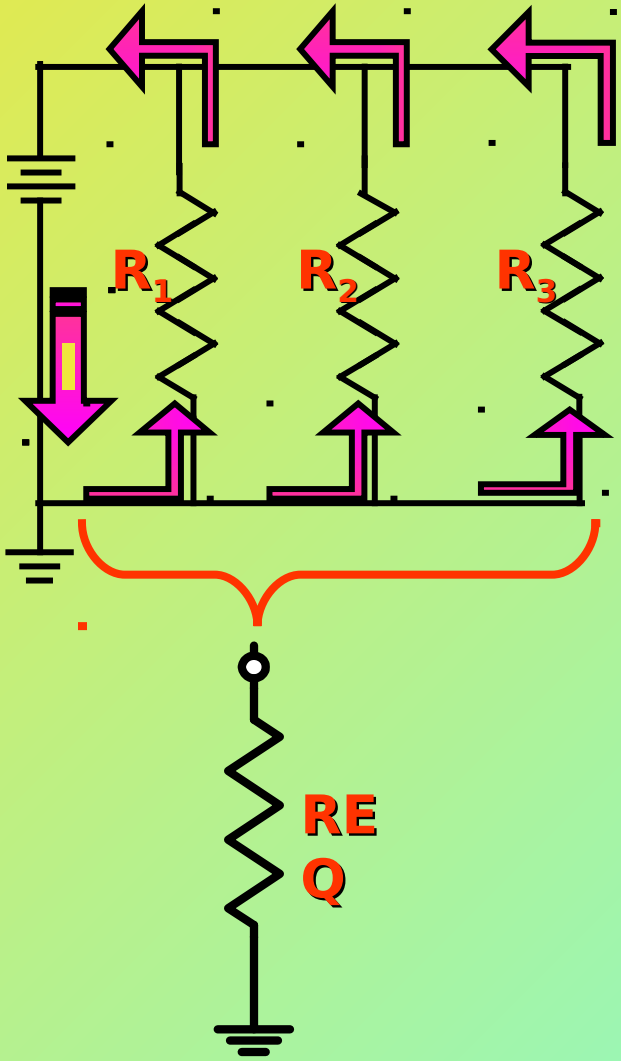
Parallel circuits is the 2nd type of Ckt used in electronics. The most common example is the power grid of our homes & business. Parallel wiring enables us to turn on & off the lights & appliances W/O interrupting the flow of Current.



REQ

DC: Parallel Circuits

Resistance; REQ



A PARALLEL CKT is defined as an electrical circuit having more than one path for Current flow.

Because there is more than one path for Current flow Resistance has to be calculated differently than it was in Series Ckts.

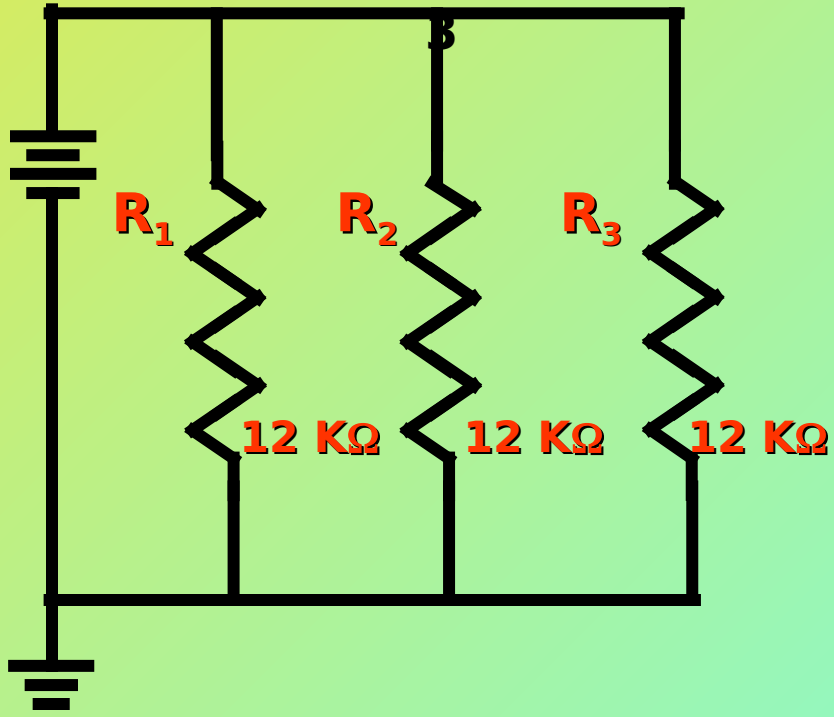
Resistance in a parallel is called the, Resistance Equivalency Quotient, or simply the REQ.

The REQ effectively reduces the parallel portion down to a singular value of resistance, this will enable us to calculate the operating parameters of the Ckt using Ohms Law.

Like Value

Calculating Resistance; Like Value Method.

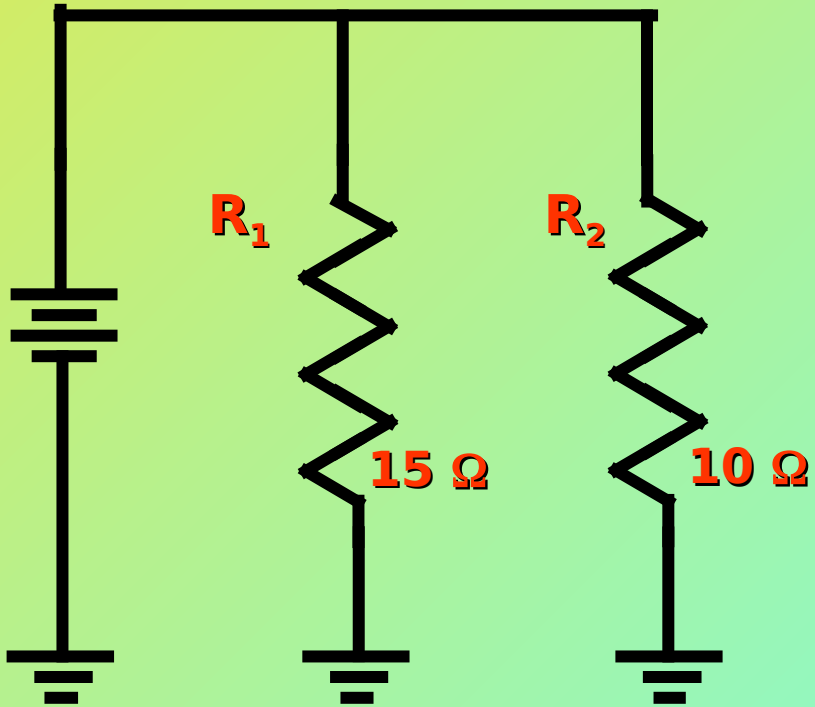
$$R_{EQ} = \frac{\text{Like Value}}{\text{\# of Resistors in Parallel}} = \frac{12\ K\Omega}{3} = 4\ K\Omega$$



Valid only for Ckts where all the resistors are of the same Value.

Calculating Resistance; Product over the Sum Method.

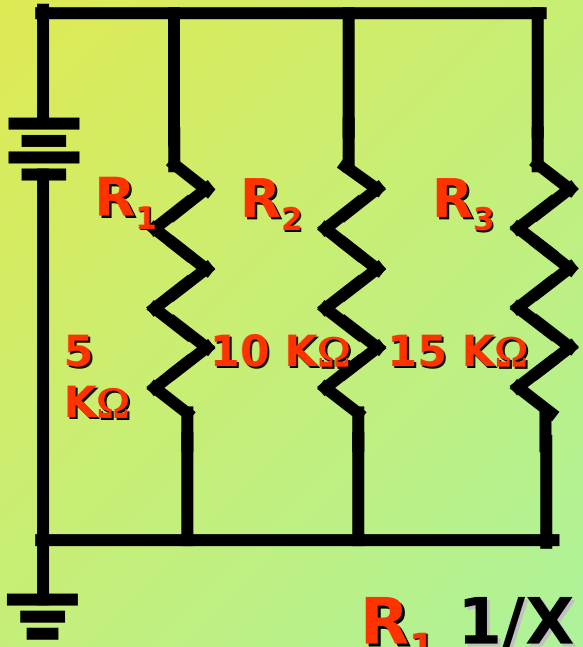
$$\frac{15\ \Omega \times 10\ \Omega}{15\ \Omega + 10\ \Omega} = \frac{150\ \Omega}{25\ \Omega} = REQ = 6\Omega$$



Valid only for Ckts comprising of 2 resistors of different Values.

Reciprocal

Calculating Resistance; Reciprocal Method.



Valid for ALL Ckts regardless of values or # of Resistors.

$$\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}} \qquad \frac{1}{\frac{1}{5\ K\Omega}+\frac{1}{10K\Omega}+\frac{1}{15K\Omega}}$$

ON the Calculator

R_1 1/X + R_2 1/X + R_3 1/X = 1/X ⇒ REQ Ω

5 K Ω 1/X + 10 K Ω 1/X + 15 K Ω 1/X = 1/X ⇒ REQ Ω

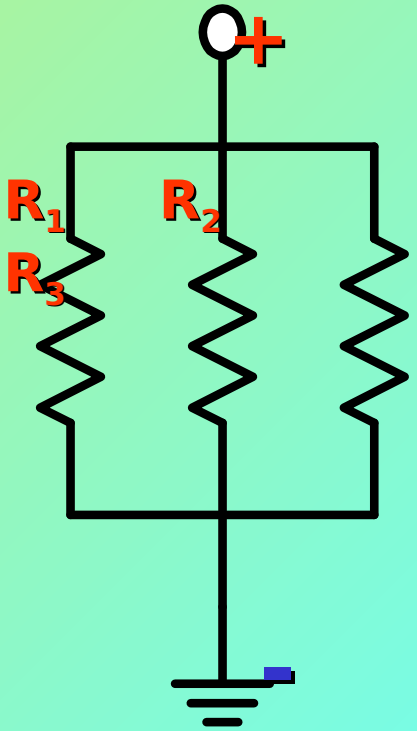
5 EE³ 1/X + 10 EE³ 1/X + 15 EE³ 1/X = 1/X ⇒ 2727. 27 Ω = 2.72 KΩ

Challenge

DC: Parallel Circuits

Calculate for the REQ , Values in R1 & 2 are the same, R3 is changed .

R_1 1/X + R_2 1/X + R_3 1/X = 1/X ⇒ REQ



10 K Ω 1/X + 15 K Ω 1/X + 30 K Ω 1/X = 1/X ⇒ __?

10 K Ω 1/X + 15 K Ω 1/X + 20 K Ω 1/X = 1/X ⇒ __?

10 K Ω 1/X + 15 K Ω 1/X + 10 K Ω 1/X = 1/X ⇒ __?

10 K Ω 1/X + 15 K Ω 1/X + 5 K Ω 1/X = 1/X ⇒ __?

10 K Ω 1/X + 15 K Ω 1/X + 1 K Ω 1/X = 1/X ⇒ __?

ANSWERS

DC: Parallel Circuits

Calculate for the REQ , Values in R1 & 2 are the same, R3 is changed .

R_1 1/X + R_2 1/X + R_3 1/X = 1/X ⇒ REQ

10 K Ω 1/X + 15 K Ω 1/X + 30 K Ω 1/X = 1/X ⇒ 5 KΩ

10 K Ω 1/X + 15 K Ω 1/X + 20 K Ω 1/X = 1/X ⇒ 4.6 KΩ

10 K Ω 1/X + 15 K Ω 1/X + 10 K Ω 1/X = 1/X ⇒ 3.75 KΩ

10 K Ω 1/X + 15 K Ω 1/X + 5 K Ω 1/X = 1/X ⇒ 2.72 KΩ

10 K Ω 1/X + 15 K Ω 1/X + 1 K Ω 1/X = 1/X ⇒ 857 Ω

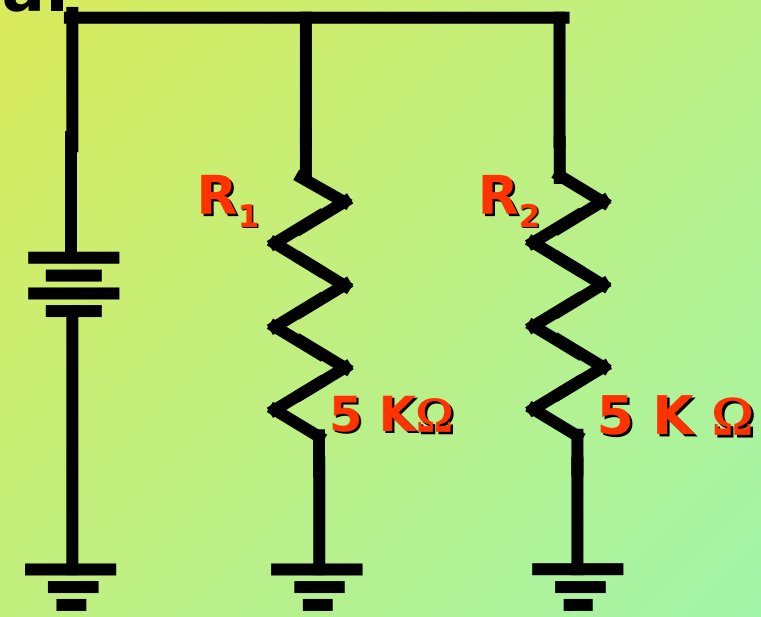
NOTE: The REQ is always smaller than the smallest resistor in the Ckt.

Go To JOB: 1

DC: Parallel Circuits

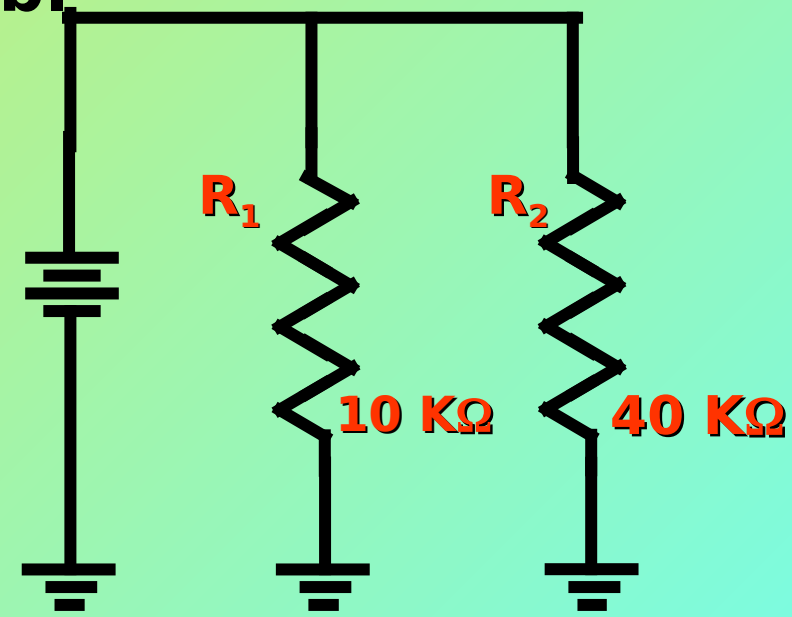
JOB 1: Solve for the REQ in each Problem, Using the associated Figure.

a.



REQ = ?

b.

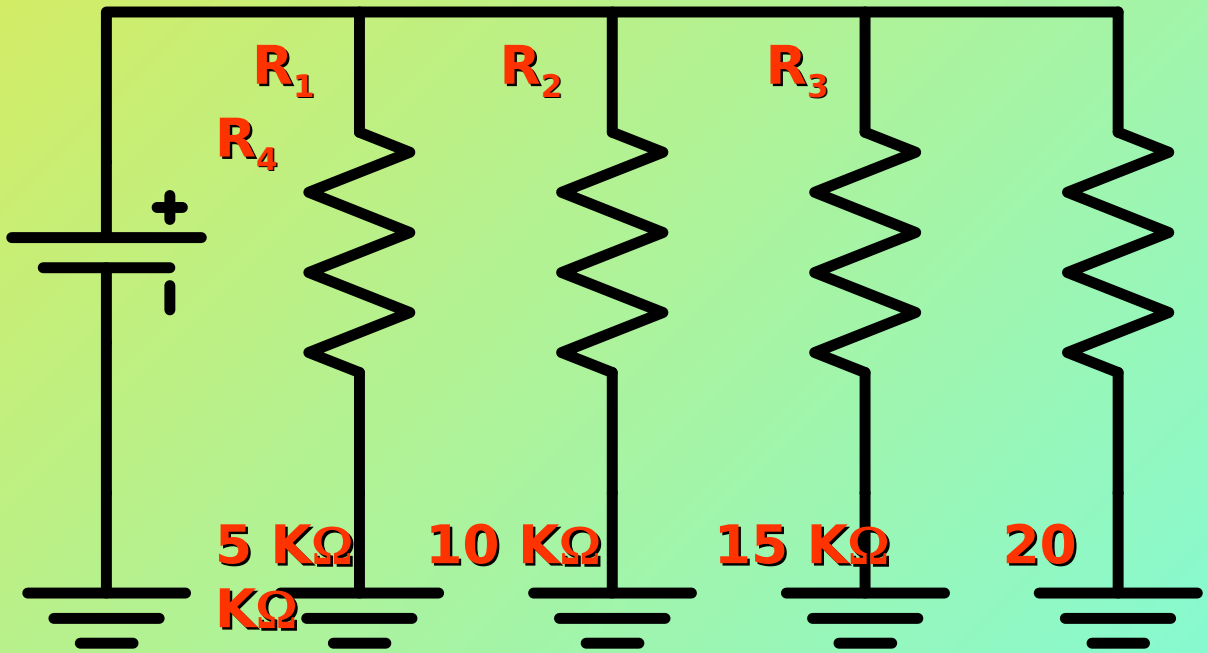


REQ = ?

Answers

JOB 1: { Cont.} Solve for the REQ in each Problem.

c.



REQ = ?

Answer c

DC: Parallel Circuits

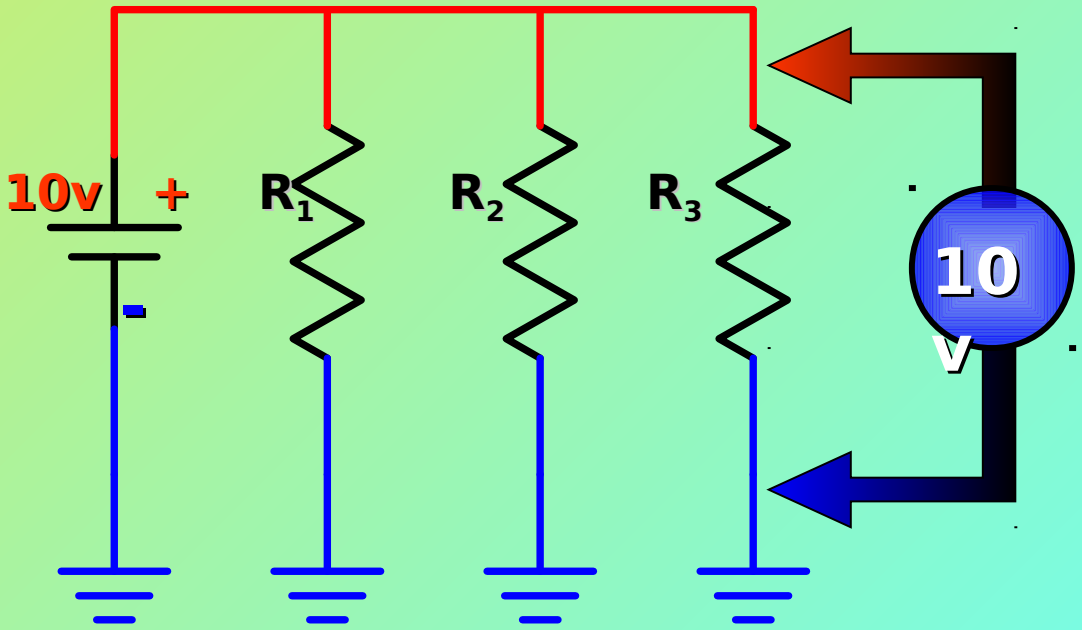
Voltage;

Voltage in a Parallel Ckt is constant or the same on each branch.

Electrically each point north & south of the resistors is the same as the Battery.

The Voltage Drop of the Parallel Ckt is called the E_{REQ}.

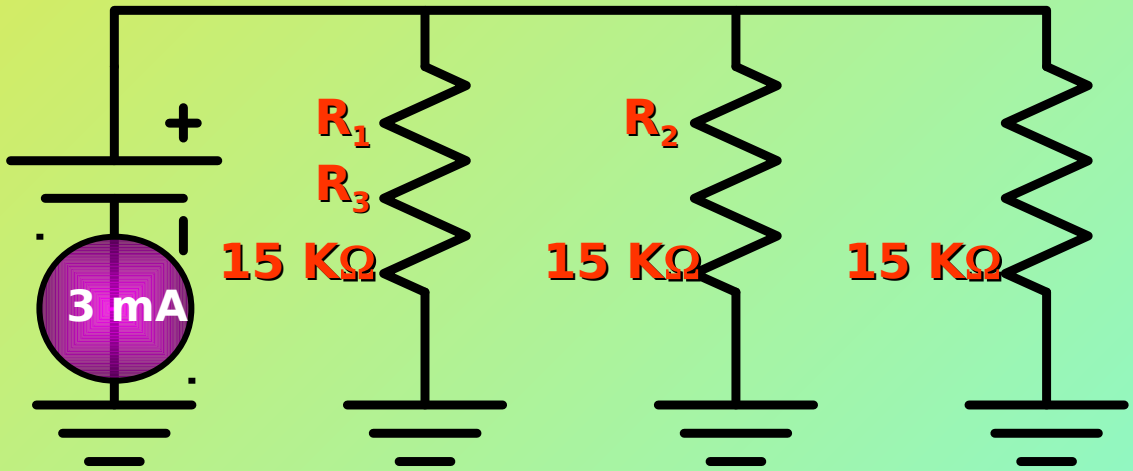
In a PURE Parallel Ckt, The E_{REQ} will = E_A.

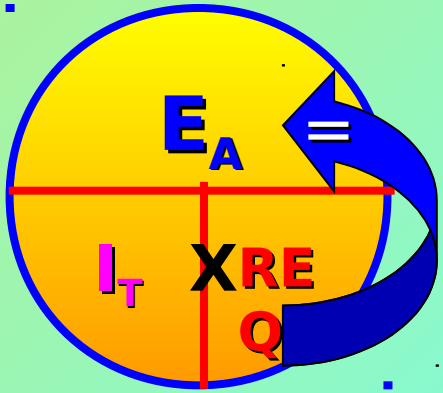


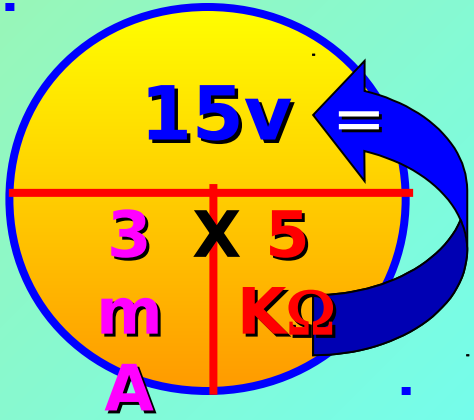
VOLTAGE, Ohms Law

Calculate for Voltage, Using Ohms Law;

E_A = ___?







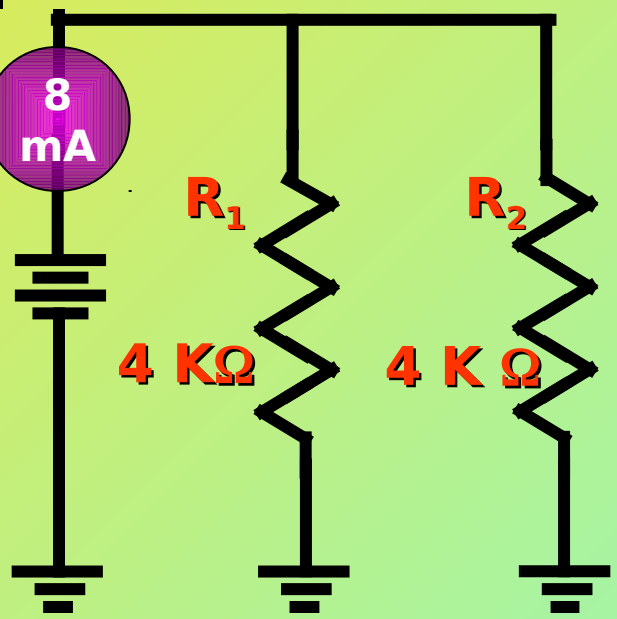
I_T X REQ = E_A 3 mA X 5 KΩ = 15v

Go To JOB: 2

DC: Parallel Circuits

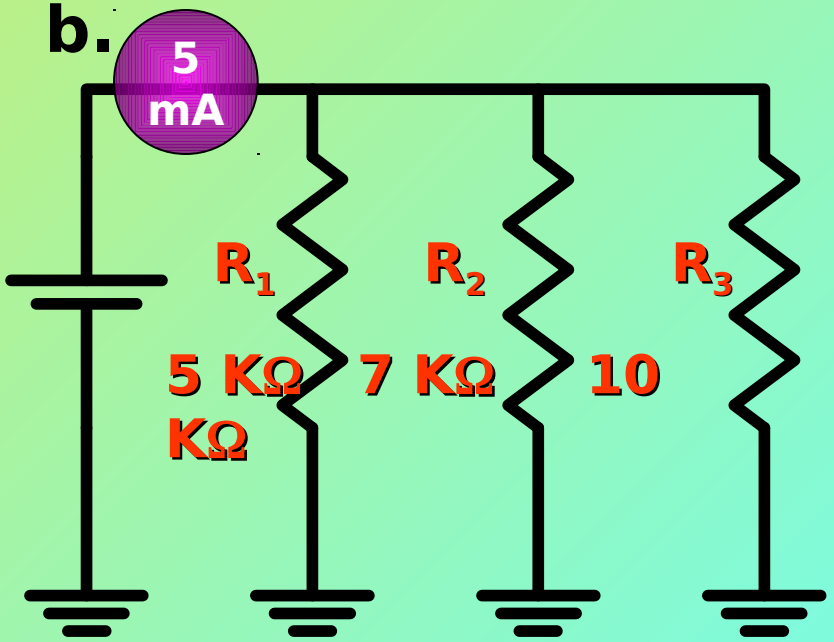
JOB 2: Solve for the Voltage in each Problem, Using the associated Figure.

a.



EA = ?

b.

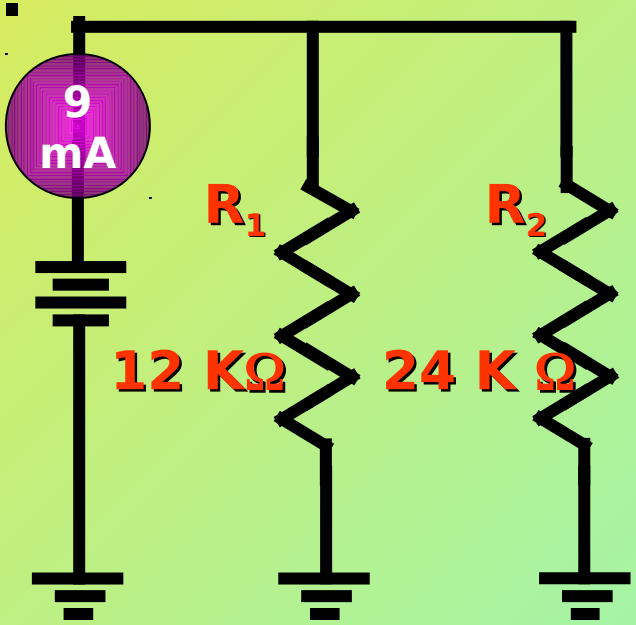


EA = ?

Answers a, b.

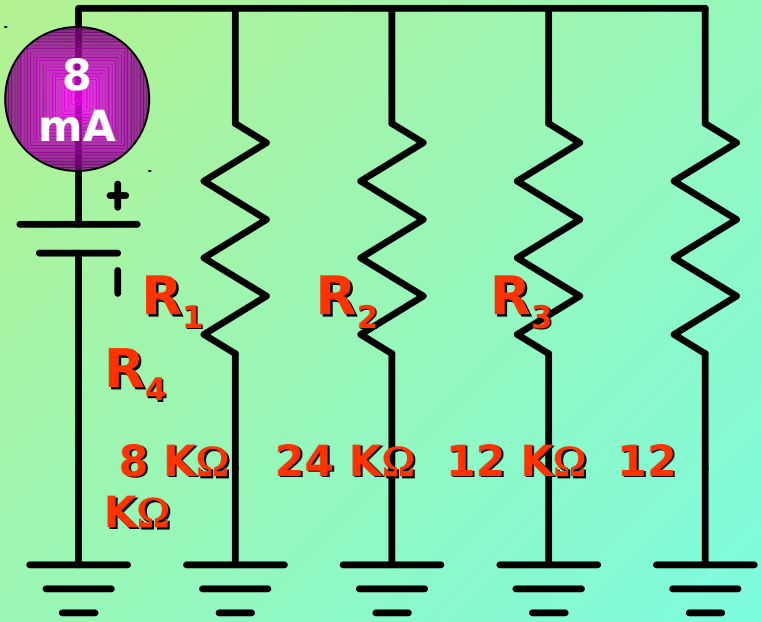
JOB 2: { Cont } Solve for the Voltage, Using the associated Figure.

c.



EA = ?

d.



EA = ? **REQ = ?**

Answers c, d

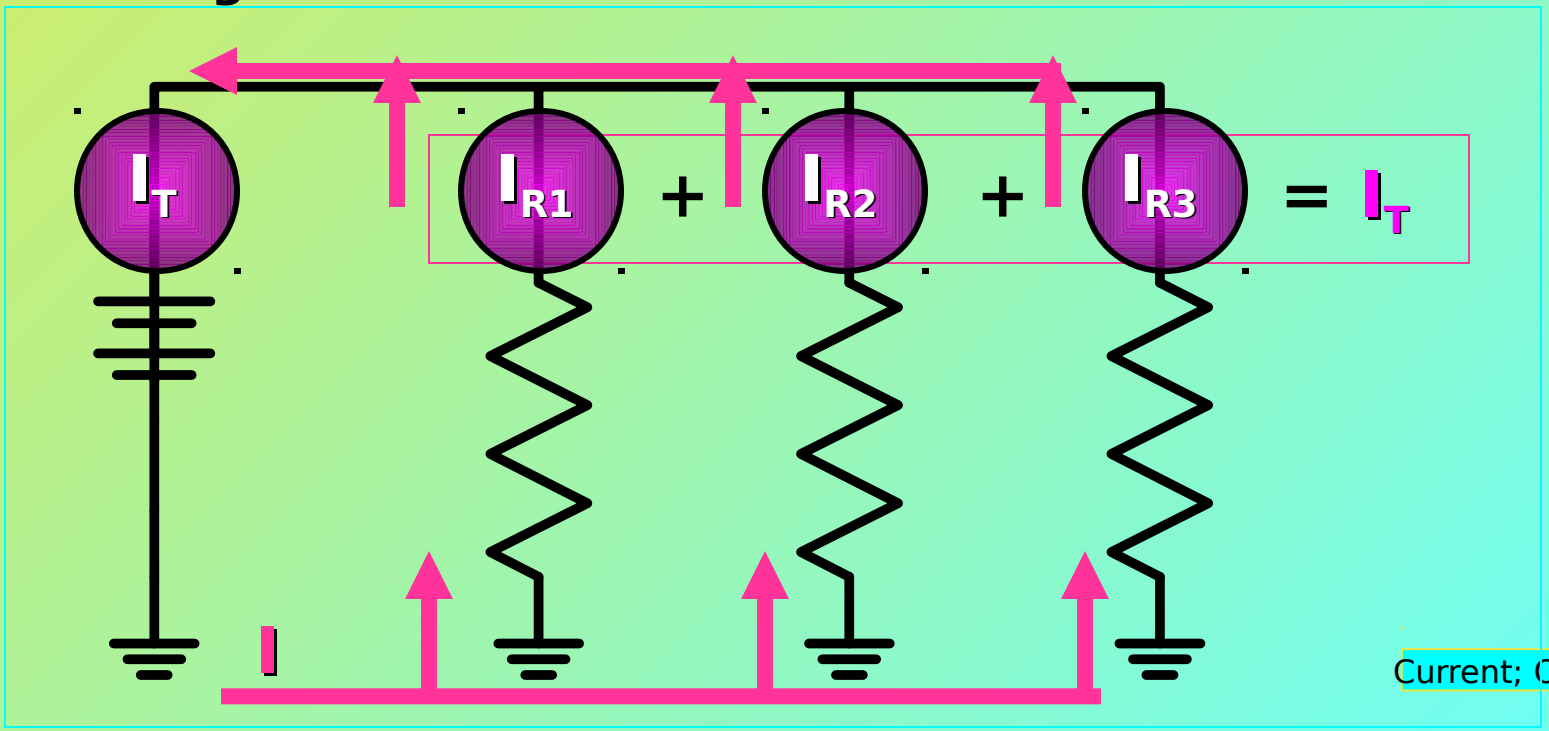
Current in a parallel Ckt:

The Sum of the Branch Currents is = I_T.

[Kirchhoff's Current Law for Parallel].

Mathematically expressed as: $I_{R1} + I_{R2} + I_{R3} = I_T$

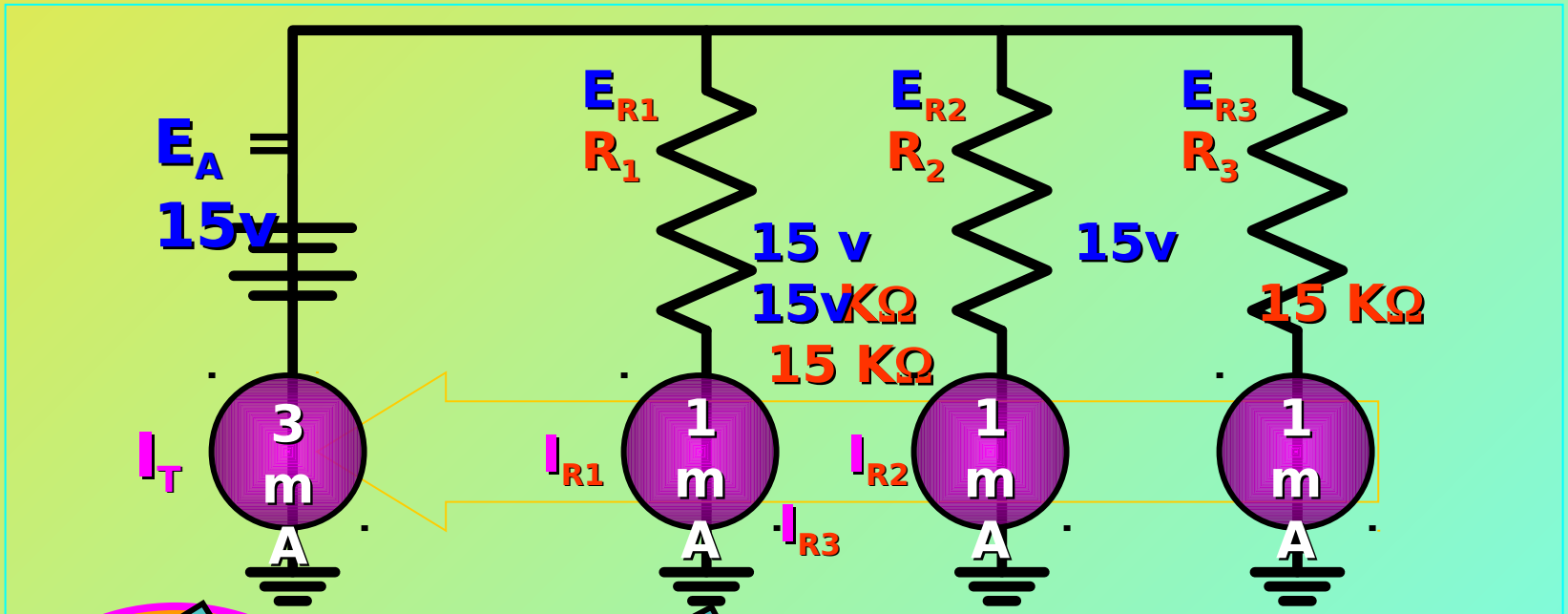
Current entering the Branch is = to the current leaving the Branch

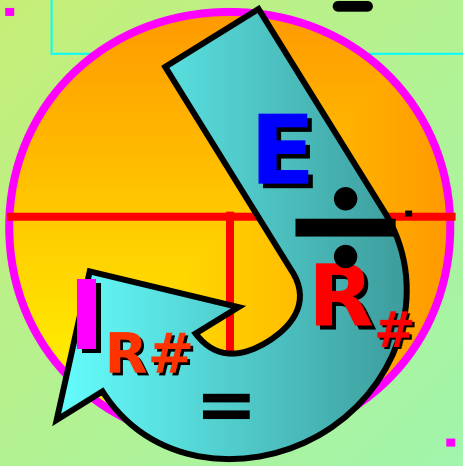


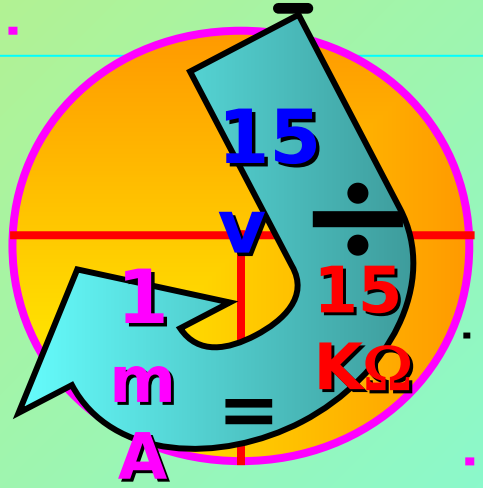
Current; OHMS LAW

DC: Parallel Circuits

Calculating for Branch Current;







Calculating for Branch current: $E \div R_{\#} = I_{R\#}$

Calculating for IT:

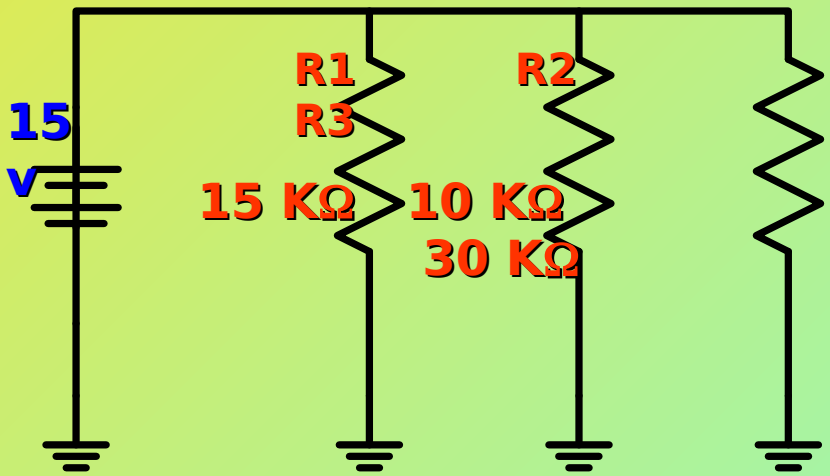
$E \div REQ = I_T$

Voltage is the same on each branch in Parallel.

Challenge

DC: Parallel Circuits

Calculate for the operating parameters in the following Ckt.



Note: E_A & E_{REQ} are the same in a Pure Parallel Ckt.

E_A = ____

REQ = ____

I_T = ____ $E_A \div REQ$

E_{R1} = ____

E_{R2} = ____

REQ

I_T X

E_{R3} = ____

I_{R1} = ____ $E_{REQ} \div R_1$

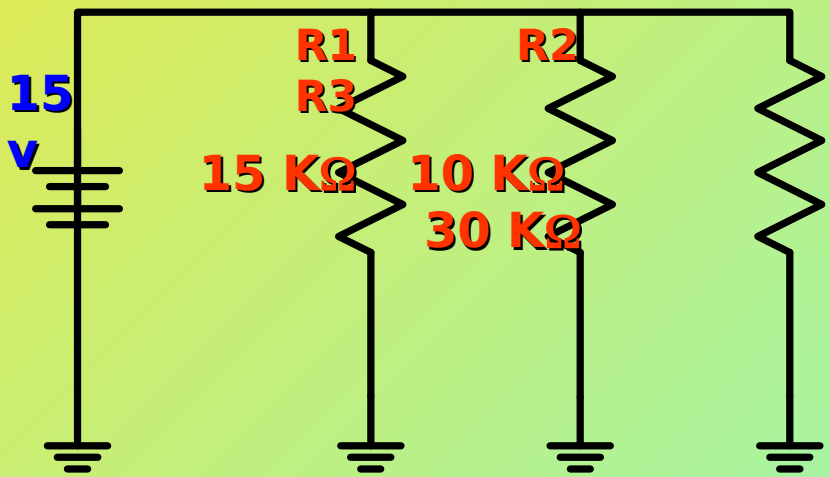
I_{R2} = ____ $E_{REQ} \div R_2$

I_{R3} = ____ $E_{REQ} \div R_3$

Answers

DC: Parallel Circuits

Calculate for the operating parameters in the following Ckt.



Note: The Smallest Resistor Carries the most Current, the Largest the Least.

E_A = 15 v

REQ = 5 KΩ

I_T = 3 mA $E_A \div REQ$

E_{R1} = 15 v

E_{R2} = 15 v } I_T X REQ

E_{R3} = 15 v

I_{R1} = 1 mA $E_{REQ} \div R_1$

I_{R2} = 1.5mA $E_{REQ} \div R_2$

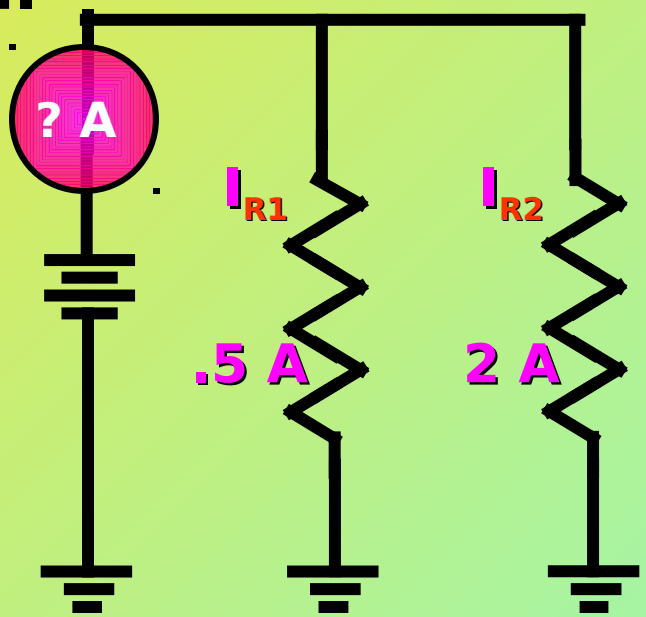
I_{R3} = .5 mA $E_{REQ} \div R_3$

Go To JOB: 3

DC: Parallel Circuits

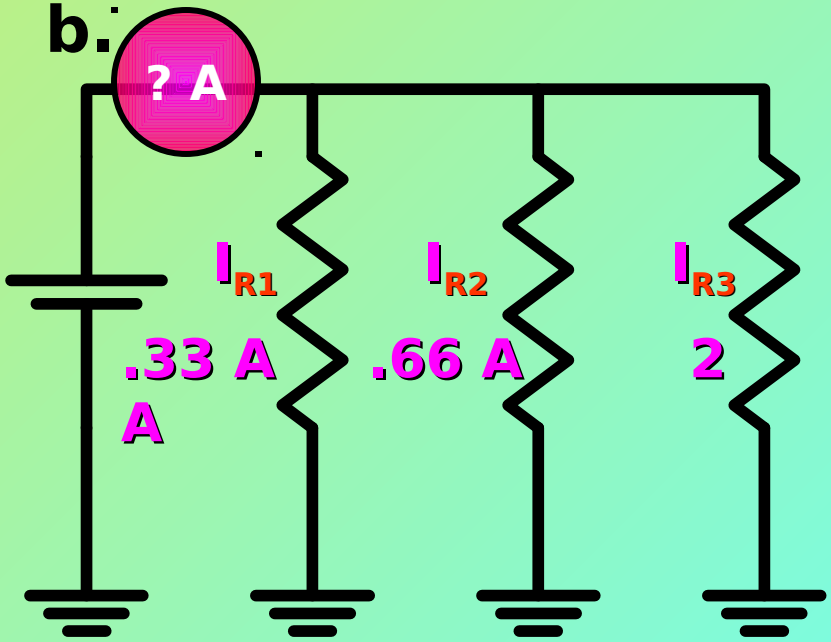
JOB 3: Find, IT in each Problem, Using the associated Figure.

a.



I_T = ____

b.



I_T = ____

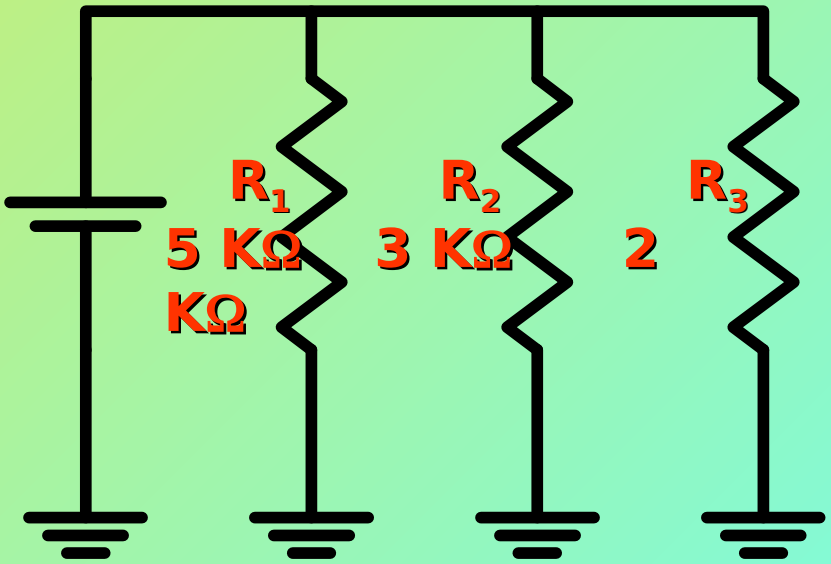
Answers a, b.

Concept Question;

Id the Resistor that carries the Most current.

Resistor :

?



R ⇑ I ⇓

Note: The Smallest Resistor Carries the most Current, the Largest the Least.

Return to lesson, Concepts

DC: Parallel Circuits

Parallel Ckt: Concepts Summary.

A Ckt W/ more than one path for Current Flow.

Resistance in the Ckt is called the **REQ**, 3 methods can be used in calculating for the REQ.

Like Value Method

Product Over the Sum

Reciprocal

Voltage is the same on all the Branches in the Ckt

The Voltage Drop of the Parallel Ckt is called the E_{REQ}, in a PURE Parallel Ckt it will = E_A.

Current, **IT** is the Sum of the Branch Currents.

$$I_{R1} + I_{R2} + I_{R3}.., = I_T$$

The Smallest resistor in parallel will pass the Most current, the Largest the least amount of

Ohms Law

DC: Parallel Circuits

Solving Ckt operating parameters W/ Ohms Law :

E_A or E_{REQ} ; [Pure Parallel Ckt].

I_T X REQ = E_A or E_{REQ}

REQ;

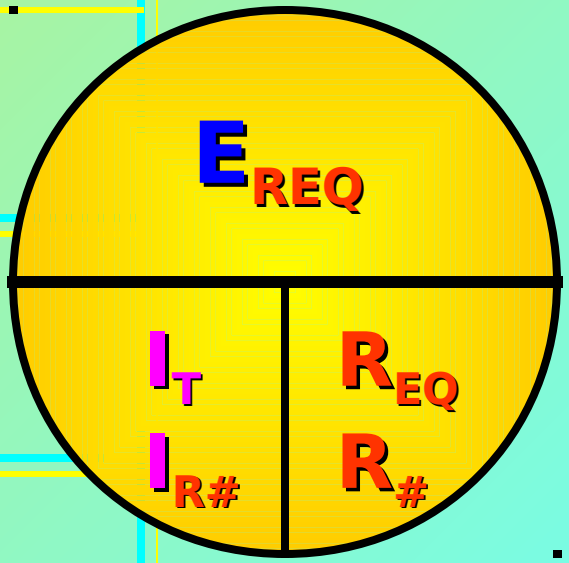
$E_{REQ} \div I_T = REQ$

I_T;

$E_{REQ} \div REQ = I_T$

$I_{R\#}$; [Branch Current]

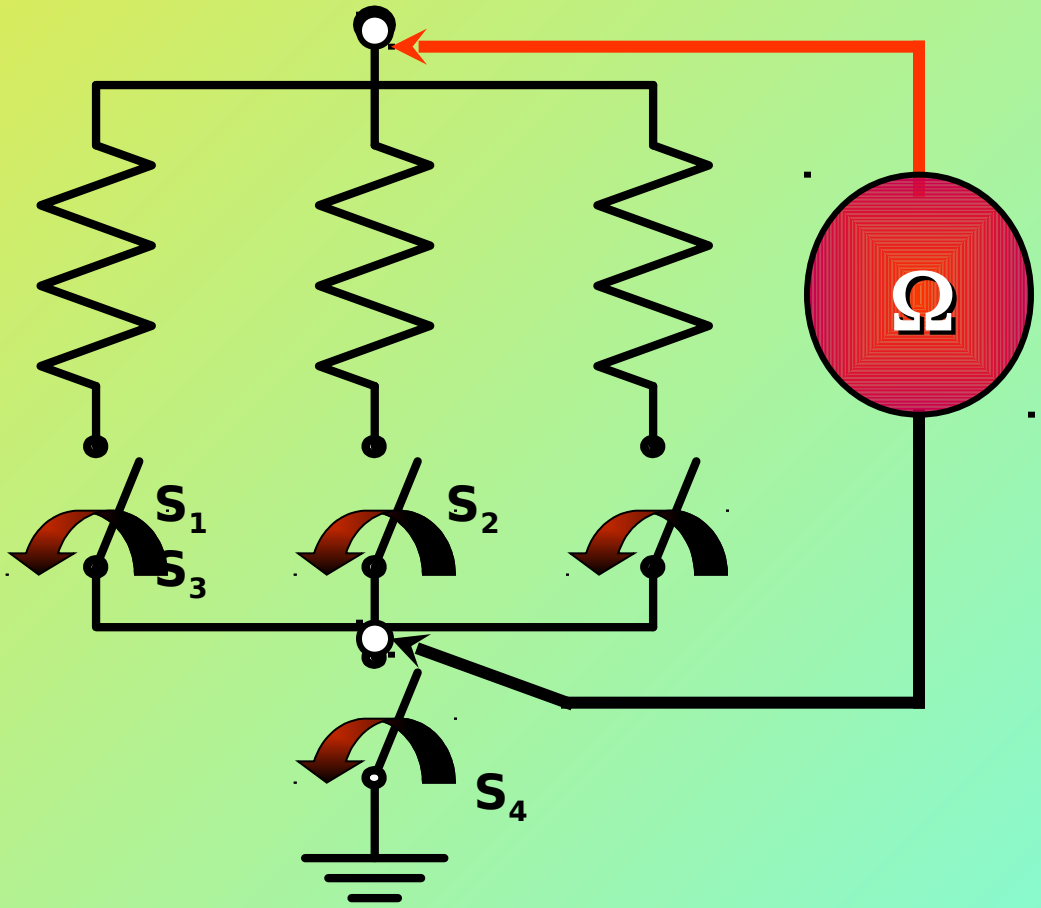
$E_{REQ} \div R_\#$



Taking Measurements

DC: Parallel Circuits

Resistance; REQ



POWER: OFF

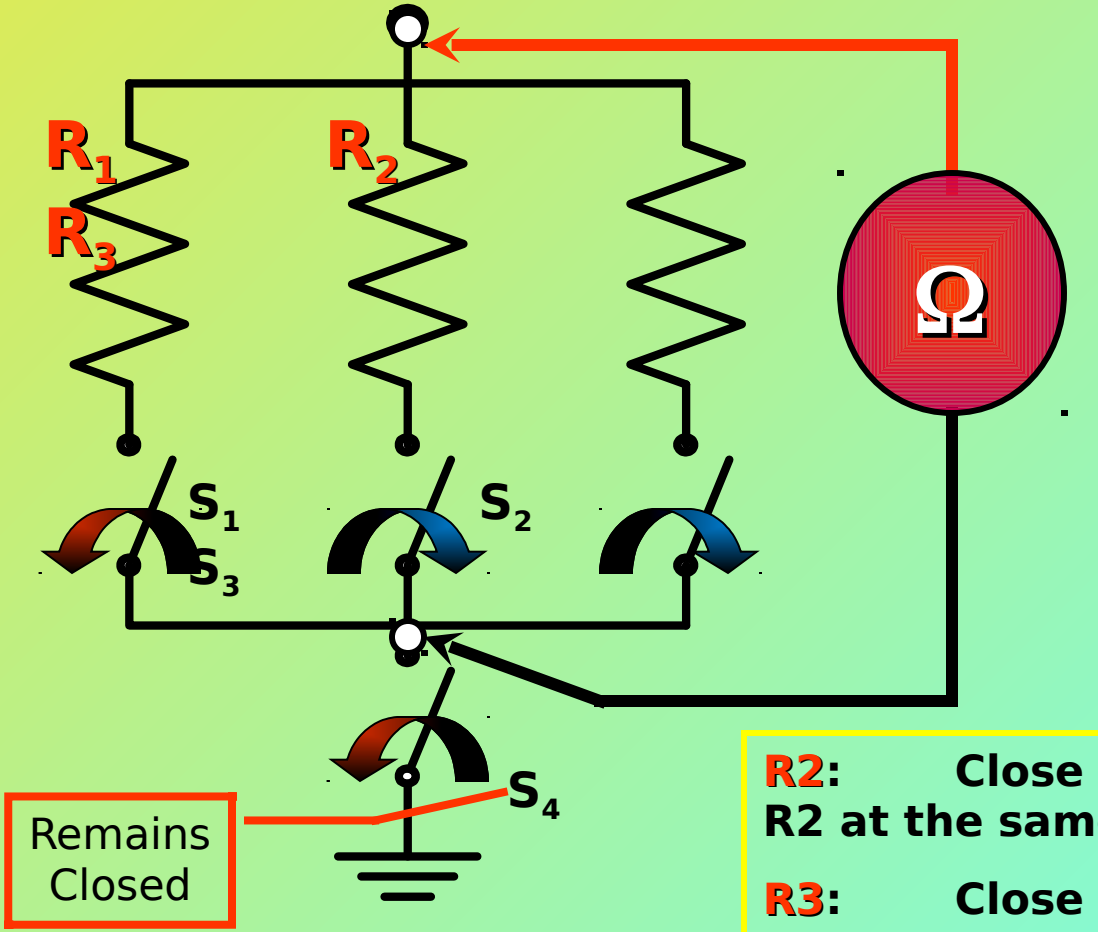
METER: Ohms

$S_{1, 2, 3, 4}$: CLOSED

LEADS: Bracket the entire Parallel Ckt, between the Red & Black leads.

Branch Resistance

Resistance; Branch Resistors: R1, 2, 3



POWER: OFF

METER: Ohms

Isolate the resistor

S1 & 4: CLOSED

S2 & 3: Open

LEADS: Bracket R1 between the Red & Black leads.

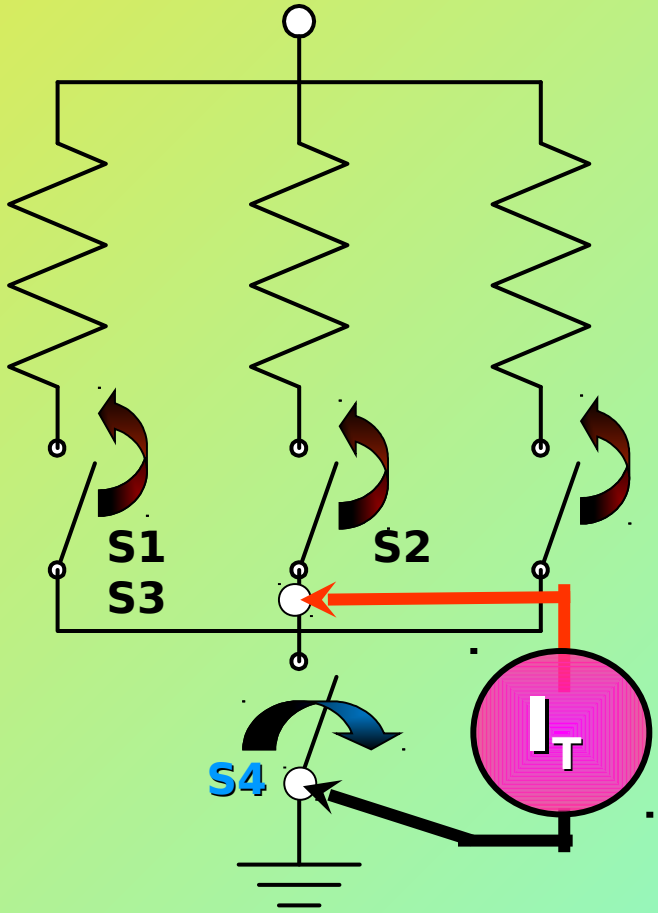
R2: Close S2, open S1, Bracket R2 at the same Test Points as R1.

R3: Close S3, open S2, Bracket R3 at the same Test Points as R1.

CURRENT

DC: Parallel Circuits

Total Current, I_T



POWER: ON

METER: CURRENT

Switches: S1, 2, 3: CLOSED

S4: Open

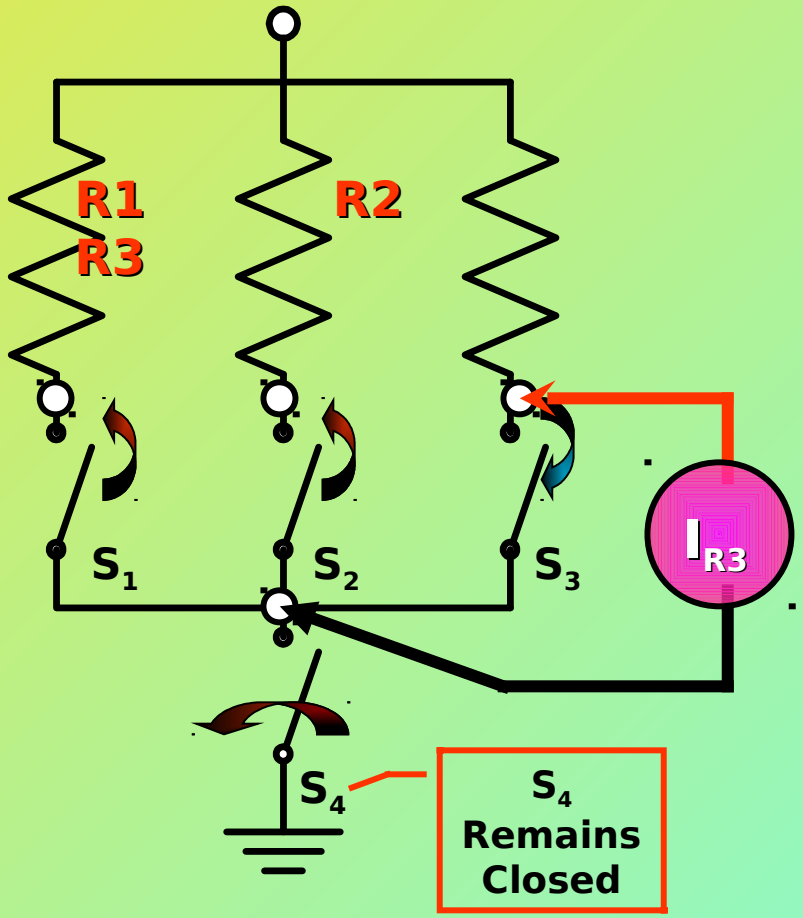
LEADS: Bracket S4 between the Red & Black leads.

Current is always Measured across an open switch !

Branch Current

DC: Parallel Circuits

Branch Current, I_{R3}



POWER: ON

METER: CURRENT

Switches: S1, 2, 4: CLOSED

S3: Open

LEADS: Bracket S3 between the Red & Black leads.

By taking the measurement across an open switch, current is given a path, thru the meter.

The switch in the branch that the measurement is being taken must be Bracketed W/Red & Black lead. All other switches must be closed.

S_1 opened for I_{R1}

S_2 opened for I_{R2}

Close

Lesson Test

Lesson Test:

Standard: 10 Questions W/in 20 minutes 70% Minimum Accuracy. 80% for EOD.

Reference: Official OMEMS Training Aids